UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/761,240	01/17/2001	Josef-Georg Bauer	GR 98 P 2124 P	5138

24131 7590 06/06/2005

LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD, FL 33022-2480

EXAMINER	
MONDT, JOHANNES P	
ART UNIT	**PAPER NUMBER**
2826	

DATE MAILED: 06/06/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/761,240	Applicant(s) BAUER ET AL.
	Examiner Johannes P. Mondt	Art Unit 2826

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 March 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☒ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

Amendment filed 3/17/05 forms the basis for this office action. In said Amendment Applicant amended the specification and the claims to overcome objections to the specification and the claims for minor informalities. Comments on Remarks in said Amendment are included below under "Response to Arguments".

Response to Arguments

1. Applicant's arguments filed 3/17/05 have been fully considered but they are not persuasive. In particular, in response to applicant's argument that the n-type recesses by Gerstenmaier et al are not stop zones because the stop zone by Applicant is *intended to prevent passage of the electric field to the p-emitter at reverse voltage by the doping as claimed* (see page 9 of Remarks, first and second paragraph), a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. See *In re Casey*, 370 F.2d 576, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 312 F.2d 937, 939, 136 USPQ 458, 459 (CCPA 1963). Applicant is referred to essentially identical comments in the previous office action regarding the unpatentable functional language ("for preventing passage...") (see page 4 of the office action mailed 9/13/04.

2. Furthermore, Gerstenmaier et al has not been cited to teach a stop zone, but instead Bauer et al was cited for teaching a stop zone. Therefore, what is to be learned

from Gerstenmaier appears to be exaggerated in Applicant's comments: the stop zone 7 by Bauer et al is a semiconductor zone abutting an emitter (6, or emitter 6 with emitter islands 8), said semiconductor zone being of a conductivity type opposite to that of the emitter. Gerstenmaier et al teach how to reduce the temperature dependence of the threshold current, which anyone in the art of thyristors would consider an obvious advantage. To this end Gerstenmaier et al recommend the selection of dopant with ionization energy at least 300 meV away from conduction and valence bands in said semiconductor zone abutting said emitter of opposite type in a thyristor. Combination of the teaching by Gerstenmaier et al of the selection of dopant with ionization energy at least 300 meV away from conduction and valence bands in said semiconductor zone abutting said emitter of opposite type in a thyristor by Bauer et al is thus seen to be both pertinent and obviously advantageous.

3. In response to applicant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning (page 10 of Remarks), it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. ***Claims 1 and 3*** are rejected under 35 U.S.C. 103(a) as being unpatentable over F. Bauer et al (5,668,385) in view of Gerstenmaier et al (DE 3917769 A1) (cf. IDS, 7/19/02). F. Bauer et al teach (cf. Figure 1b, title, abstract, and col. 4, l. 32 – col. 6, l. 60) a power semiconductor element (cf. title), comprising:

a semiconductor substrate 1 (cf. abstract and col. 4, l. 54) doped with doping atoms of a first conductivity type (n-type) (col. 4, l. 54) (N.B.: that the doping is with atoms is inherent: in this regard it is noted that "ion" is a narrower term of "atom");

an emitter region 6/8 (cf. col. 5, l. 64 – col. 6, l. 3) doped with doping atoms of a second conductivity type (p-type);

said emitter region and said semiconductor substrate having mutually opposite conductivities (p and n are hole and electron conductivities, hence are inherently conductivities that are mutually opposite, electron conductivity being conductivity of negative-charge carriers and hole conductivity being conductivity of positive-charge conductivity);

a stop zone 7 (cf. abstract and 4, l. 59-61) in front of the emitter region (cf. Figure 1c); the limitation "for preventing passage of an electric field to said emitter region at a reverse voltage" constitutes functional language irrelevant to the present device claim,

drawn as it is to a device rather than a method of using a device; hence only the structure is relevant, and the structure in the application and the structure in the prior art (anode 7, p-emitter 6, n-stop zone and n-substrate 1 in the application, versus anode 5, p-emitter 6/8, n stop zone 7 and n-substrate 1 in the embodiment of Figure 1b in the prior art by F. Bauer et al) is fully analogous (Parenthetically, F. Bauer et al indeed teach the electric field to be reduced to yield an almost field-free zone within the stop zone 7, enabling faster recombination of charges, which implies faster reverse recovery (cf. col. 3, l. 30 – 40));

said emitter region 6/8 and said stop zone 7 having mutually opposite conductivities (we already saw that the emitter region is p-type (cf. col. 5, l. 64 – col. 6, l. 3), while the stop zone 7 is of n-type conductivity: see col. 4, l. 59-60); and said stop zone having atoms of a doping substance of said first conductivity type determining a conductivity of said stop zone (i.e., said stop zone is n-doped: see col. 4, l. 59-60).

F. Bauer et al do not teach the further limitation that said atoms of said doping substance have at least one energy level within the band gap of the semiconductor and at least 200 meV away from both a conduction band and a valence band of the semiconductor wherein a number of effective doping atoms generated in the stop zone changes in dependence on whether the power semiconductor element is in a blocking operation or in a conducting operation.

However, it would have been obvious to include said further limitation in view of Gerstenmaier et al, who, in a published patent application on a thyristor (cf. title; hence closely related to the GTO (Gate-Turn-Off) thyristor-relevant art by F. Bauer et al; see F.

Bauer, abstract), teach that in n-type recesses 11 (cf. col. 2, l. 4) between p-emitter portions 4 (cf. col. 1, l. 53-57) on the anode (A) side (cf. Figure 1) the dopant should be selected so as to have an ionization energy level within the band gap of the semiconductor and at least 300 meV away, a forteriori at least 200 meV away, from both a conduction band and a valence band of the semiconductor (cf. col. 2, l. 49 – col. 3, l. 17), *for the specifically stated purpose* to reduce the temperature dependence of the threshold current (cf. abstract and col. 2, l. 30 – col. 3, l. 17) through an increase in the slope of the conductivity versus temperature. The strong dependence on temperature of the occupancy level of the conduction band (cf. col. 3, l. 2-6) inherently implies the number of effective doping atoms generated in the stop zone, i.e., the number of atoms having contributed a charge carrier to the conduction band, to change in dependence on whether the power semiconductor element is in a blocking operation (no ohmic heating) or in a conducting operation (ohmic heating), because in the conducting state the temperature is higher relative to the blocking state in view of the ohmic heating associated with any current flow in a resistive medium.

Motivation to include the teaching by Gerstenmaier in this regard in the invention by F. Bauer et al derives from the resulting constancy, hence increased reliability, of the threshold voltage as well as the broadening of the temperature range towards higher temperatures within which the maximal blocking voltage of the thyristors can be secured (cf. col. 1, l.27-37).

Combination of the teaching by Gerstenmaier et al with the invention by F. Bauer is easily achieved by selecting the dopant according to the criterion by Gerstenmaier on

ionization energy levels in relation to the semiconductor band gap (Gerstenmaier lists a few examples, such as Molybdenum, Germanium, Cesium, Barium, Selenium and Niobium; for additional possibilities see S.M. Sze, "Physics of Semiconductor Devices", page 21, in which a list is provided including the case specifically cited by Gerstenmaier et al when the semiconductor is silicon (cf. col. 3, l. 13)). The practical implementation of the combination only involves selecting the dopant for the recesses between p-emitter regions 8 within stop layer 7 (cf. Figure 1b). Success of the implementation of said combination can therefore be reasonably expected.

On claim 3: Gerstenmaier specifically teaches the selection of Se (Selenium) as the dopant for said recessed, i.o.w., the inclusion of Selenium atoms in said atoms (cf. col. 3, l. 17).

3. ***Claim 4*** is rejected under 35 U.S.C. 103(a) as being unpatentable over F. Bauer et al (5,668,385) in view of Gerstenmaier et al (DE 3917769 A1). F. Bauer et al teach (cf. Figure 1b, title, abstract, and col. 4, l. 32 – col. 6, l. 60) a power semiconductor element (cf. title), comprising:

a semiconductor substrate 1 (cf. abstract and col. 4, l. 54) doped with doping atoms of a first conductivity type (n-type) (col. 4, l. 54) (N.B.: that the doping is with atoms is inherent: in this regard it is noted that "ion" is a narrower term of "atom");

an emitter region 6/8 (cf. col. 5, l. 64 – col. 6, l. 3) doped with doping atoms of a second conductivity type (p-type);

said emitter region and said semiconductor substrate having mutually opposite conductivities (p and n are hole and electron conductivities, hence are inherently

conductivities that are mutually opposite, electron conductivity being conductivity of negative-charge carriers and hole conductivity being conductivity of positive-charge conductivity);

a stop zone 7 (cf. abstract and 4, l. 59-61) in front of the emitter region (cf. Figure 1c); the limitation "for preventing passage of an electric field to said emitter region at a reverse voltage" constitutes functional language irrelevant to the present device claim, drawn as it is to a device rather than a method of using a device; hence only the structure is relevant, the structure in the application and the structure in the prior art (anode 7, p-emitter 6, n-stop zone and n-substrate 1 in the application, versus anode 5, p-emitter 6/8, n stop zone 7 and n-substrate 1 in the embodiment of Figure 1b in the prior art by F. Bauer et al) being fully analogous (Parenthetically, F. Bauer et al indeed teach the electric field to be reduced to yield an almost field-free zone within the stop zone 7, enabling faster recombination of charges, which implies faster reverse recovery (cf. col. 3, l. 30 – 40));

said emitter region 6/8 and said stop zone 7 having mutually opposite conductivities (we already saw that the emitter region is p-type (cf. col. 5, l. 64 – col. 6, l. 3), while the stop zone 7 is of n-type conductivity: see col. 4, l. 59-60); and said stop zone having atoms of a doping substance of said first conductivity type determining a conductivity of said stop zone (i.e., said stop zone is n-doped: see col. 4, l. 59-60).

F. Bauer et al do not teach the further limitation that said stop zone contains foreign atoms (i.e., not native to the semiconductor substrate) selected from the group consisting of Sulfur and Selenium with at least one energy level within the band gap of

the semiconductor and spaced at least 200 meV away from both a conduction band and a valence band of the semiconductor wherein a number of effective doping atoms generated in the stop zone changes in dependence on whether the power semiconductor element is in a blocking operation or in a conducting operation.

However, it would have been obvious to include said further limitation in view of Gerstenmaier et al, who, in a published patent application on a thyristor (cf. title; hence closely related to the GTO (Gate-Turn-Off) thyristor-relevant art by F. Bauer et al; see F. Bauer, abstract), teach that in n-type recesses 11 (cf. col. 2, l. 4) between p-emitter portions 4 (cf. col. 1, l. 53-57) on the anode (A) side (cf. Figure 1) the dopant should be selected so as to have an ionization energy level within the band gap of the semiconductor and at least 300 meV away, a forteriori at least 200 meV away, from both a conduction band and a valence band of the semiconductor (cf. col. 2, l. 49 – col. 3, l. 17), *for the specifically stated purpose* to reduce the temperature dependence of the threshold current (cf. abstract and col. 2, l. 30 – col. 3, l. 17) through an increase in the slope of the conductivity versus temperature, while Gerstenmaier specifically cite Selenium (cf. col. 3, l. 17). The strong dependence on temperature of the occupancy level of the conduction band (cf. col. 3, l. 2-6) inherently implies the number of effective doping atoms generated in the stop zone, i.e., the number of atoms having contributed a charge carrier to the conduction band, to change in dependence on whether the power semiconductor element is in a blocking operation (no ohmic heating) or in a conducting operation (ohmic heating), because in the conducting state the temperature

is higher relative to the blocking state in view of the ohmic heating associated with any current flow in a resistive medium.

Motivation to include the teaching by Gerstenmaier in this regard in the invention by F. Bauer et al derives from the resulting constancy, hence increased reliability, of the threshold voltage as well as the broadening of the temperature range towards higher temperatures within which the maximal blocking voltage of the thyristors can be secured (cf. col. 1, l.27-37).

Combination of the teaching by Gerstenmaier et al with the invention by F. Bauer is easily achieved by selecting the dopant according to the criterion by Gerstenmaier on ionization energy levels in relation to the semiconductor band gap (Gerstenmaier lists a few examples, such as Molybdenum, Germanium, Cesium, Barium, Selenium and Niobium; for additional possibilities see S.M. Sze, "Physics of Semiconductor Devices", page 21, previously made of record (5/15/2002) , in which a list is provided including the case specifically cited by Gerstenmaier et al when the semiconductor is silicon (cf. col. 3, l. 13)). The practical implementation of the combination only involves selecting the dopant for the recesses between p-emitter regions 8 within stop layer 7 (cf. Figure 1b). Success of the implementation of said combination can therefore be reasonably expected.

4. ***Claim 2*** is rejected under 35 U.S.C. 103(a) as being unpatentable over F. Bauer et al and Gerstenmaier et al as applied to claim 1 above, and further in view of Tohyama (5,684,323). *As detailed above, claim 1 is unpatentable over F. Bauer et al in view of Gerstenmaier et al.*

Although neither F. Bauer et al nor Gerstenmaier et al specifically teach the further limitation that the selection of said atoms is to include sulfur (S), it would have been obvious to include said further limitation because sulfur (S) has long been applied as a dopant in silicon for its deep ionization level so as to tailor the current-voltage characteristics of said silicon, as witnessed by Tohyama (cf. col. 6, l. 66 – col. 7, l. 11) (note that the doping in Gerstenmaier et al also serves the same purpose: the resulting temperature dependence of the occupancy levels of the conduction band inherently leads to a desired change in the current-voltage characteristic due to ohmic heating. Applicant once again is reminded that sulfur (S) is known to meet the physical criterion stated by Gerstenmaier et al for the selection of said atoms, as evidenced by the scientific data on donor and acceptor ionization energies of sulfur (S) in silicon (see e.g., S.M. Sze, "Physics of Semiconductor Devices", Figure 13, page 21, previously made of record (5/15/2002)): from said list it is evident that sulfur satisfies the aforementioned physical criterion. It is thus evident from Tohyama that *combination* of the teaching by Tohyama of the inclusion of sulfur as the deep ionization energy dopant only requires standard doping techniques and may be *motivated* by specific design considerations on the desired current-voltage characteristics, determined as the latter are by the depth of the energy levels. Finally, Applicant is reminded in this regard that it has been held that mere selection of known materials generally understood to be suitable to make a device, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. In re Leshin 125 USPQ 416.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P. Mondt whose telephone number is 571-272-1919. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J. Flynn can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

JPM
May 20, 2005